CLIMATE NARRATIVE, December 2019 and as noted

UNITED STATES WEST COAST AND NORTH PACIFIC

During late December 2019 US west coast (20-150 km offshore) satellite derived sea surface temperatures (SST_D) were 9°-11°C north of 45°N, 11°-13°C south of 45°N to 39°, 12°-15°C south of 39°N to 33°N and 14°-18°C south of 33°N, off southern California and northern Mexico. Neutral to positive (≤2°C) SST_D anomalies occurred along the coast from northern Mexico to the Gulf of Alaska, with the larger anomalies occurring toward the north and offshore. North of 40°N, a large area (≥ 300,000 km^2) of positive SST_D anomaly occurred offshore 150 km and extended across the northeastern Pacific to the date line (180°E/W)). However there was reduction in positive SST_D anomaly extent in this region during December, especially south of 40°N where areas of weak negative SST_D anomaly became more common. Large areas of positive SST_D anomaly (≤2°C) were seen in the central North Pacific extending to the equator and along the western Pacific boundary reaching from Taiwan to northern Japan (22° - 40°N).

During late December, **sea level height anomalies** (SLA), -15 to 20 cm, appeared in areas reaching zonally across the North Pacific. An equatorial zone had positive SLA (≤10 cm) form 120°W to 160°E, with weak negative SLA (≥-10 cm) to the east and west. At 15°N a band of negative SLA, deepest (≥ -25 cm) from 120°W to 140°W, extended from the coast of Panama to the Philippines and northward into the East China Sea. North of 20°N, positive SLA (≤25 cm) was common west of 140°W, particularly near 30°N,150°W. https://www.ospo.noaa.gov/Products/ocean/sst/anomaly/
https://coastwatch.pfeg.noaa.gov/elnino/coastal_conditions.html (current)
https://coastwatch.pfeg.noaa.gov https://climatereanalyzer.org/wx/DailySummary/#sstanom (current)
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ocean/weeklyenso_clim_81-10/wksl_anm.gif
https://www.ospo.noaa.gov/Products/ocean/sst/contour/index.html

Late December composite **satellite imagery** of the US west coast showed surface **chlorophyll-a** (chl-a) at 0.2- 2.0 mg/m^3 in coastal bands alongshore from 34°N, off the upper Southern California Bight (SCB), to the Columbia River (46.0°N). Except for a nearshore band of elevated chl-a (≤ 4 mg/m^3) alongshore extending around the SCB and into northern Mexico, chl-a concentrations were less than 1 mg/m^3 off the lower SCB. Between 33°N and 39°N coastal chl-a concentrations formed an irregular band (50-250 km) extending seaward from the coast. North of Point Arena (39°N), bands of elevated chl-a (≤2.0 mg/m^3) reached 800-1000 km to the west. Surface chl-a concentrations decreased off northern California, Oregon and Washington during December.
https://coastwatch.pfeg.noaa.gov/coastwatch/CWBrowserWW180.jsp#
https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdVHNchla8day.graph?chla[(2019-12-26T00:00:00Z)][(0.0)][(83.65125):(-0.10875)][(-193.76625):(-110.00625)]&.draw=surface&.vars=longitude%7Clatitude%7Cchla&.colorBar=%7C%7C%7C%7C%7C&.bgColor=0xffccccff
https://coastwatch.pfeg.noaa.gov/coastwatch/CWBrowserWW180.jsp#
https://www.star.nesdis.noaa.gov/sod/mecb/color/ (current and animations)

Lists of monthly sea temperature at shore and near-shore buoys

Shore and nearshore water temperature locations are given in decreasing latitude. Each line begins with station latitude followed by a station or buoy abbreviation. Temperature values are in brackets with the average of available monthly values first (followed by the range) in parens. Averages for the (first, second and third) monthly thirds, respectively, are within the second parens, followed by the multiyear monthly

average, where available. Subscripts H and L indicate the third when Highest and Lowest temperatures were recorded.

List (December 2019)

Amphitrite Point, B.C. 48.9°N

Neah,8.5°N,124.7°W [8.9(8.0-9.9)(8.8,9.2LH,8.6)8.8°C]

Cape Flattery 48.4°N

NeBy,48.4°N [8.2(6.5-8.9)(7.6L,8.5H,8.4°C)]

CpEz,47.4°N,124.7°W [9.8(9.0-10.7)(9.8,9.7LH,9.9) 9.6°C]

TlMk,46.9°N,125.8°W [11.1(10.0-12.2)(11.7L,11.2,10.3H)10.9°C]

Cape Blanco 42.8°N

PrtO,42.7°N [10.8(9.7-11.6)(10.6L,11.1H,10.7°C)]

CCty,41.7°N [10.6(8.9-11.5)(10.1L,10.9H,10.9°C)]

EelR,40.7°N,124.5°W [12.0(9.8-13.0)(11.5,12.3H,12.3L)]11.6°C]

Point Arena 39°N

ArCv,38.9°N [11.9(10.2-12.7)(11.7L,12.2H,11.9°C)]

Point Reyes 38°N

SFrn,37.8°N,122.8°W [12.9(11.5-13.7)(12.7,12.9H,13.0L)11.8°C]

Mtry,36.6°N [14.0(12.4-14.7)(13.9L,14.3H,13.7°C)]
PrtS,35.1°N [14.2(13.2-15.7)(14.4L,14.6H,13.5°C)]

PtCn,34.5°N,120.8°W [14.8(13.2-16.3)(15.4L,14.9,14.1H°C)]

Point Conception,34.4°N

SBCh,34.3°N,119.9°W [15.1(13.5-16.6)(15.7L,15.3,14.2H)14.5°C]
Smca,34°N [15.6(14.1-17.0)(16.2,15.7H,14.9L °C)]

Tory,32.9°N,177.4°W [15.3(14.3-16.5)(15.7L,15.5H,14,8°C)]
LaJo,32.9°N [16.0(14.8-17.1)(16.6H,16.2, 15.3L°C)]

Point Loma, 32.7°N

Shore measurements, taken at a fixed depth below the lowest tide at NOAA **tide stations**, are indicated by: *NeBy* (9443090), *PrtO* (9431647), *CCty* (9419750), *ArCv* (9416841), *Mtry* (9413450), *PrtS* (9412110), *Smca* (9410840), *LaJo* (9410320) in. Numbers lead to detailed location and station descriptions, https://tidesandcurrents.noaa.gov/stations.html?type=Physical%20Oceanography. Details of nearshore buoy measurements are obtained from number designations: Neah (46087), CpEz (46041),TlMk (46089),EelR (46022), SFrn (46026), PtCn (46218), SBCh (46053), Tory

(46225). https://www.ndbc.noaa.gov/station_page.php?station=46087
https://coastwatch.pfeg.noaa.gov/erddap/tabledap/cwwcNDBCMet.htmlTable?&station=%2246225%22&time%3E=2019-11-08T00%3A00%3A00Z&time%3C=2019-11-15T00%3A00%3A00Z

EQUITORIAL AND SOUTH PACIFIC (late December and as noted)

Positive SST_D anomaly (≤2°C) extended across the Equatorial Pacific (EP) during December. Greatest EP SST_D anomalies persisted near 180°E/W and this area extended into the North Pacific. Models suggest (≤60% estimated probability) that current El Niño-neutral conditions will persist through the boreal winter and possibly into spring and summer. Eastern EP upper 300-meter heat content anomaly weakened through November, then increased through December. Positive subsurface temperature anomalies (≤2.5°C) increased above 200 m depth between 170°W and 160°E and above 40 m east of 110°W, with the eastward propagation of a downwelling Kelvin wave. Negative subsurface temperature anomaly in the EP decreased through December. Night-time satellite imagery indicated three areas (≥500,000km^2) of negative SST_D anomaly centered near 20°S, 100°W, 40°S,120°W and 45°S, 140°W. The highest SST_D anomaly (≤3.5°C) of the Pacific Ocean was centered near 40°S at the date line.

Sea level height anomaly (SLA) was negative (≤-15cm) along the eastern Pacific boundary from 25° to 5°S. This area extended west to 170° W at 6°S and to 130°W at 12°S. Positive SLA was typical of the South Pacific at the date line. At the western boundary, negative anomaly occurred from northern Australia to the Sea of Japan (20°S-40°N). http://www.ospo.noaa.gov/Products/ocean/sst/anomaly/
https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ocean/weeklyenso_clim_81-10/wksl_anm.gif
https://www.ospo.noaa.gov/Products/index.html

The NOAA **Oceanic El Niño Index** (ONI) (3-month running mean of SST anomalies in the Nino 3.4 region) increased and was marginally El Niño-positive (0.5) for October-November-December. This is the largest value since July 2019.
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf
https://climatedataguide.ucar.edu/climate-data/multivariate-enso-index (alternate index)

The December NOAA/NCEI **Pacific Decadal Oscillation Index** (PDO), calculated from ERSST.v4, was neutral (-0.04). PDO and ONI indices are recalculated and may change as data are assimilated into ERSST.v4. https://www.ncdc.noaa.gov/teleconnections/pdo/ , http://research.jisao.washington.edu/pdo/PDO.latest.txt

The **Pacific / North American Teleconnection Index** (PNA), computed from atmospheric pressure over the Pacific Ocean and North America had near neutral daily values from October through December. The December monthly mean value was 0.13.
https://www.cpc.ncep.noaa.gov/data/teledoc/pna.shtml (see computational alternatives).

December monthly ERD/SWFSC coastal **Upwelling Indices** (UI) were negative from 39° to 60°N and strongly negative from 54°-57°N, indicating seasonal cyclonic winds. Weakly positive UI values were computed for 24°- 30°N.
https://upwell.pfeg.noaa.gov/products/PFELData/upwell/monthly/table.1912 Daily UI calculations indicate favorable upwelling conditions at 39°N at the end of December and strongly unfavorable conditions (-UI) on 1-7 and 17-20 December.
https://oceanwatch.pfeg.noaa.gov/products/PFELData/upwell/daily/p09dayac.all (see computational alternatives)

PRECIPITATION and RUNOFF (late December)

Heavy precipitation occurred along the U.S. west coast during mid to late December. However, water year to date (since October 1) precipitation deficits of more than 12 inches, and basin average snow water content less than 50%, support short term drought designation across parts of northern California, Oregon and Washington. A vigorous storm front crossed central and southern California from December 25 to 27 bringing moderate to heavy rain and high-elevation snow (see Notes). Snowfall amounts exceeded two feet in the mountains of southern California. December snow also fell in the Cascades, where abnormal dryness improved. https://droughtmonitor.unl.edu.

Fraser River discharge, measured at Hope (130 km upriver from Vancouver, B.C.), was 1,300 m^3/s (45,900 cubic feet /sec or cfs) in late December. The multi-year median for Hope is 900 m^3/s. https://wateroffice.ec.gc.ca The **Puyallup River** at Puyallup, WA was flowing at 3,730 cfs [1,360 -historical median as cfs in brackets]. **Skagit River** flow was 27,500 [13,700 cfs] near Mount Vernon. **Stillaguamish River** discharge was 4,040 [1,840 cfs] at Arlington. **Columbia River** transport at the Dalles was 116,000 [108,000 cfs] and 140,000 [149,000 cfs] at Vancouver WA. The **Wilson River** at Tillamook, OR was flowing at 3,290 [1,739 cfs]**.** At Elkton, **Umpqua River** transport was 9,160 [9,230 cfs]. **Rogue River** flow was 2,270 [3,160 cfs] at Grants Pass and 3,990 [5,560 cfs] at Agness. The **Klamath River** near Klamath, CA was transporting 7,020 [14,800 cfs]. **Smith River** discharge was 2,210 [4,460 cfs] near Crescent City. The **Eel River** at Scotia had 2,090 [6,560 cfs] transport. At the **Battle Creek,** Coleman National Fish Hatchery the flow was 328 [380 cfs]. **Butte Creek** at Chico had 201 [154 cfs] transport. **Sacramento River** transport was 14,000 [15,900 cfs] at Verona and 14,900 [18,800 cfs] at Freeport. **San Joaquin River** flow was 2,230 [2,370 cfs] at Vernalis. **Pescadero Creek** transport was 12 [15 cfs] near Pescadero. **San Lorenzo River** discharge was 51 [33 cfs] at Santa Cruz. The **Pajaro River** at Chittenden was flowing at 46 [23 cfs]. The **Salinas River** near Spreckels was had low flow [9 cfs]. The **Carmel River** at Carmel was flowing at 131 [16 cfs]. The **Big Sur River** near Big Sur, CA discharged at 144 [40 cfs].

https://waterdata.usgs.gov/ca/nwis/current/?type=flow
https://www.cnrfc.noaa.gov/awipsProducts/RNOWRKCLI.php= (current)
https://wateroffice.ec.gc.ca/search/real_time_results_e.html
https://www.cpc.ncep.noaa.gov/products/global_monitoring/precipitation/global_precip_accum.shtml

Notes

Atmospheric Rivers (AR) enhanced two storms that swept across southern and central California 22-27 December 2019. These two storms brought 2-5 inches of rain to coastal CA and accounted for 15-30% of normal annual precipitation https://cw3e.ucsd.edu/. An AR is a large, often slow-moving low pressure center off of the West Coast of North America that taps into tropical moisture. In the case of the **Pineapple Express** AR, the moisture is channeled, from as far away as Hawaii, by the subtropical jet steam towards the US West Coast where topographic uplift leads to precipitation as the moist air flows toward and over the mountain range. Rains, snow, hurricane force winds, floods and mudslides may occur. Contaminated run-off severely pollutes nearshore environments. Katarina Gonzales and others examined records of ARs occurring between 1980 and

2015 and found that those that were moisture and wind driven were the most likely to deliver heavy precipitation and related problems to the western states. Winds appear as important in the prediction of coastal impacts as moisture content.
https://agu.confex.com/agu/fm19/meetingapp.cgi/Paper/524563 https://cw3e.ucsd.edu/wp-content/uploads/2019/12/31Dec19_Summary/Slide2.PNG https://www.nasa.gov/feature/goddard/2017/nasa-sees-pineapple-express-deliver-heavy-rains-flooding-to-california http://tenaya.ucsd.edu/~dettinge/czd_jhm2013.pdf

Oregon had low precipitation and stream flow during fall 2019 that is affecting **salmon spawning**. A recent **Wilson River die-off** of fall-run Chinook prompted Oregon Department of Fish and Wildlife (ODFW) to close the river to all salmon angling, effective Dec. 7 – 31. Low water conditions during November led to concentrations of fall Chinook in the lower river where conditions were conducive to the spread of cryptobia, a naturally occurring amoebic parasite that causes anemia and death. An ODFW survey of the lower Wilson River found 200 dead adult Chinook. Evidence of scavenging and failure to view deeper holes suggests higher mortality. ODFW Fish-Health staff confirmed the presence of cryptobia in retrieved carcasses. The closure is to preserve remaining fall Chinook adults for spawning. The fall Chinook run is below average this year. Substantial losses of spawners could affect future stocks. Cryptobia is present in other basins and in other salmon species. Similar mortalities are occurring elsewhere in the northwest. The strategy followed on the Wilson River may be effective because rains in December brought Wilson River flow that exceeded long term medians, freeing Chinook adults to continue upriver and disperse into spawning grounds.
www.myodfw.com.

This Narrative may be found, https://coastwatch.pfeg.noaa.gov/elnino/coastal_conditions.html
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